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ORIGINAL ARTICLE

EARLY DETECTION OF HEARING IMPAIRMENT IN HIGH RISK NEW-BORNS

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ABSTRACT

Aim: To determine risk factors of hearing impairment in high risk neonatal intensive care unit (NICU) graduates.

Methods and Material: This hospital-based prospective observational study was conducted in the NICU graduates of a tertiary center of eastern India from June 2014 to May 2015. Our study population included 130 infants of which 65 were with high-risk factors (hypoxic-ischemic encephalopathy stage II and III, neonatal hyperbilirubinemia, neonatal sepsis/meningitis, and prematurity) and another 65 normal term infants, who had no adverse perinatal clinical events. Brainstem Evoked Response Audiometry (BERA) was performed by Auditory Evoked Potential Machine before one month of age. Those infants who failed to pass the test were asked for repeat testing after 3 weeks of their initial testing. Follow up of the high-risk babies was done at 1 month, 3 months, 6 months, 9 months and at one year. Factors such as birth weight, gender, days of neonatal intensive care unit (NICU) stay and effects on BERA were analyzed.

Results: Out of 65 cases, 15 (23.07%) had birth asphyxia, 20 (30.76%) had hyperbilirubinemia, 10 (15.38%) cases were neonatal sepsis/ meningitis and 20 (30.76%) were of gestational age <37 weeks. On initial BERA screening, 8 (53.33%) cases of birth asphyxia, 9 (45%) cases of hyperbilirubinemia, 2 (20%) cases of sepsis/meningitis and 6 (30%) premature babies had abnormal BERA results of which 3 (4.61%) cases had persistent BERA abnormality after a period of 1 year of follow up of which 3 (4.61%) cases had persistent BERA abnormality after a period of 1 year of follow up. Out of those 3 babies, 2 had severe birth asphyxia with encephalopathy and one had gestational age <37 weeks with other risk factors. Out of 65 controls, no BERA abnormality was detected. In patients with hyperbilirubinemia who had received only one exchange transfusion, abnormal BERA was seen in 3 (23%) on initial screening whereas those who had received 2 exchange transfusion, abnormal BERA was seen in 6 (85.7%) (p=0.03). Similarly, in 15 premature babies with associated risk factors (apnea, hypoglycemia, hypocalcemia, prolonged oxygen use), abnormal BERA was seen in 5 (33.33%) and in 5 premature babies without other risk factors,1 (20%) had abnormal BERA (p=0.001) on initial screening.

Conclusion: Neonates with high-risk factors should have their hearing screening done by the age of one month and confirmation by 3 months and intervention by 6 months of age.

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Introduction

Congenital hearing loss is a major abnormality that threatens the adequate development of a child. Adequate hearing within the first year of life is critical for the development of speech and cognitive functions of infants.[1] Neonatal hearing loss often goes undetected as hearing loss is a hidden disability. As many as 126,000-500,000 babies are affected yearly, 90% of which live in developing countries.[2] Congenital sensorineural hearing impairment has been estimated at 1.2-5.7/1000 live births.[3-7] The American Academy of Pediatrics (AAP) Task Force on new-born and infant hearing recommends Universal New-born Hearing Screening (UNHS) by 3 months of age with intervention by 6 months of age.[8] We did this study to find out the risk factors associated with hearing impairment in neonatal intensive care unit (NICU) graduates.

Methods & Materials

This hospital-based prospective cohort study was conducted for one year in the follow-up clinic of a tertiary care hospital in Kolkata, India. Our study

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population included 130 infants of which 65 were with high-risk factors and another 65 were normal term infants, who had no adverse perinatal clinical events. Investigator picked up a total of 74 cases by consecutive sampling from the high-risk clinic in the study period (for the first three months in the one-year study). From 74 high-risk neonates, 65 new-borns followed up for one year. We collected age and sex-matched normal new-borns from the well-baby clinics as controls. Our study population included following high-risk babies: a) neonates with prematurity <37 weeks, b) birth asphyxia (hypoxic-ischemic encephalopathy grade II & III), c) neonatal hyperbilirubinemia (total bilirubin $\geq$20 mg/dl or requiring exchange transfusion), d) neonatal sepsis/meningitis. HIE stage was determined by Sarnat classification.[8] Neonatal meningitis was determined if the cerebrospinal fluid cell count >20 cells/hpf. Neonatal sepsis was determined if there were clinical features of infection with or without bacteremia and at least two sepsis screens positive .[9] The Joint Committee on Infant Hearing (JCIH) position statement provides guidelines that include New-born Hearing Screening soon after birth, before discharge from hospital, or before one month of age. This screening involves all new-borns, with special attention to the high-risk group.[10] Neonates with HIE grade I, neonatal jaundice (total bilirubin <20 mg/dl), neonates who had been treated with aminoglycosides, neonates with major congenital abnormality were excluded as it has been seen that HIE stage I has no sequelae as 98-100% of newborns will have normal neurological outcome[8] and use of aminoglycosides might be a confounding factor for our study. Children with major congenital anomalies usually have poor survival and thus were excluded. Co-morbidities in form of hypoglycemia (blood sugar level <45 mg/dl) and hypocalcemia (serum calcium <7 mg/dl)[9] were noted. Children were included in the study after approval of the institutional ethics committee and written consent of the parents.

The high-risk clinic was conducted by two assistant professors trained in the Developmental Assessment Scale of Indian Infants (DASII) and the Denver Developmental Screening Test (DDST). Detailed history followed by clinical examination was done in all patients. Brainstem Evoked Response Audiometry (BERA) was performed by Auditory Evoked Potential Machine manufactured by Medicare system India with TDH39 headphones before one month of age.[10] BERA findings were analyzed in terms of the auditory threshold, wave morphology, latency, and interwave intervals. The records were said to be abnormal when the threshold for hearing was increased, wave I-III Inter Peak Latency (IPL) was >2 msec, wave I-V IPL was >4 msec and morphology of wave V was poor. Hearing loss was defined as mild when the hearing threshold was between 26-40 decibels (dBHL), moderate when the hearing threshold was between 41-55 dBHL, severe when the hearing threshold was between 71-90 dBHL and profound when the hearing threshold was above 91 dBHL. An infant was considered to have a normal threshold for hearing if wave V at 30 dBHL was present in both ears or one ear at dBHL and the other ear at 45 dBHL. The infants who passed the initial test were not asked to return for follow up BERA. At the age of one month, the failed groups were asked for repeat testing after 3 weeks after their initial screen. Follow up of the high-risk babies was done at 1 month, 3 months, 6 months, 9 months and one year. On every follow-up visit, their weight, length and head circumference were measured and plotted on Fenton chart up to 40 weeks of post-conceptional age for preterm babies & thereafter on World Health Organization (WHO) growth charts. A neurological examination was performed using the Amiel-Tison method. The developmental screening was performed using the DDST chart. Those found to have developmental delays were assessed by DASII to assess Motor Development Quotient (MoDQ) and Mental Development Quotient (MeDQ). Factors such as birth weight, gender, days of neonatal intensive care unit (NICU) stay and effects on BERA were analyzed. Proportions were analyzed by Chi-square using SPSS software version 16. p-value >0.05 was considered as significant.

Results

Mean gestational age of the cases were 35.23 $\pm$ 2.53 weeks and controls were 39.92 $\pm$ 0.34 weeks. Mean birth weight of the cases was 2.54 $\pm$ 0.48 kg and controls were 3.14 $\pm$ 0.22 kg. Male: female ratio in cases was 40:25 and that in controls was 38:27. Out of 65 cases, 15 (23.1%) had birth asphyxia, 20 (30.8%) had hyperbilirubinemia, 10 (15.4%) had neonatal sepsis/meningitis and 20 (30.8%) were premature. On initial BERA screening, 8 (53.33%) cases of birth asphyxia, 9 (45%) cases of hyperbilirubinemia, 2 (20%) cases of sepsis/meningitis and 6 (30%) premature babies had abnormal BERA results. Out of 8 cases of BA with a hearing abnormality, 5 had mild and 3 had profound hearing loss (HL). In patients with hyperbilirubinemia, 7 had mild HL and 2 had moderate HL. In neonatal sepsis/meningitis, 2 had mild HL, in premature babies 3 had mild HL, 2 had moderate HL and 1 had profound HL. Out of 65 normal babies screened, we found abnormal BERA in one baby but on subsequent screening, at 3 months there was no hearing impairment. Mean value of wave I-III IPL was 1.96 $\pm$ 0.4 in cases and 1.90 $\pm$ 0.2 in controls (p=0.281) and for I-IV IPL was 4.86 $\pm$ 0.6 in cases and 4.66 $\pm$ 0.26 in controls (p=0.015) on initial screening. Factors associated with abnormal BERA on initial screening are depicted in table 1. In 15 premature babies with associated risk factors (apnea, hypoglycemia, hypocalcemia, prolonged oxygen use), abnormal BERA was seen in 5 (33.33%) and 5 premature babies without other risk factors,1 (20%) had abnormal BERA (p=0.001) on initial screening. In patients with hyperbilirubinemia who had received only one exchange transfusion, abnormal BERA was seen in 3 (23%) on initial screening whereas those who had received 2 exchange transfusion, abnormal BERA was seen in 6 (85.7%) (p=0.03). On follow up visit at 12 months, 3 (4.6%) cases had persistent BERA abnormality of which 2 had HIE and 1 patient had prematurity with multiple risk factors (apnea, hypoglycemia, hypocalcemia, prolonged oxygen use). By DDST, 14 (21.5%) cases had developmental delay and 3 (3.1%) controls had developmental delay. All three babies with persistent BERA abnormality had developmental delays.

Table 1. Factors associated with abnormal BERA on initial screening

Factors	Clinical Condition	Normal BERA n (%)	Abnormal BERA n (%)	P value
	HIE (n=15)			
Birth weight				0.81
≥2.5 kg	8	3 (37.5%)	5 (62.5%)	
<2.5 kg	7	4 (57.1%)	3 (42.85%)	
Gender				0.67
Male	11	6 (54.54%)	5 (45.45%)	
Female	4	1 (25%)	3 (75%)	
Stage of HIE				0.36
Stage 2	10	6 (60%)	4 (40%)	
Stage 3	5	1 (20%)	4 (80%)	
NICU stay				0.17
≥8 days	6	1 (16%)	5 (83.33%)	
<8 days	9	6 (66.66%)	3 (33.33%)	
	Hyperbilirubinemia (n=20)			
Birth weight				0.62
≥2.5 kg	11	5 (45.45%)	6 (54.54%)	
<2.5 kg	9	6 (66.66%)	3 (33.33%)	
Gender				0.79
Male	15	9 (60%)	6 (40%)	
Female	5	2 (40%)	3 (60%)	
NICU stay				0.93
≥8 days	12	7 (58.33%)	5 (41.66%)	
<8 days	8	4 (50%)	4 (50%)	
	Neonatal sepsis/meningitis (n=10)			
Birth weight				0.63
≥2.5 kg	6	5 (83.33%)	1 (16.66%)	
<2.5 kg	4	3 (75%)	1 (25%)	
Gender				
Male	3	2 (66.66%)	1 (33.33%)	0.86
Female	7	6 (85.71%)	1 (14.28%)	
NICU				
≥8 days	8	6 (75%)	2 (25%)	
<8 days	2	2 (100%)	-	
	Prematurity (n=20)			
Gender				
Male	11	7 (63.63%)	4 (36.36%)	0.84
Female	9	7 (77.77%)	2 (22.22%)	
NICU				
≥8 days	16	11 (68.75%)	5 (31.25%)	0.71
<8 days	4	3 (75%)	1 (25%)	

Discussion

The incidence of hearing impairment in high-risk neonates is from 5 to 50 per 1000 live births.[12-13] The incidence of hearing impairment in our study population was 46.15/1000 population which is comparable. In one study from Lucknow, India[14] it was found that the prevalence of BERA abnormalities on initial screening was 43.3% with very low birth weight (<1500 gm), congenital intrauterine infection, hyperbilirubinemia, bacterial meningitis, and ototoxic drugs as risk factors. Most of the clinical adverse factors in the present study (viz. prematurity <34 wks, birth asphyxia, neonatal hyperbilirubinemia requiring exchange transfusion, neonatal sepsis ± meningitis) have already been recognized to be important for producing hearing impairment in the affected neonates.[14]

In our study, 38% had mild to a profound hearing abnormality on initial screening. According to another study, 28% patient had mild to profound hearing loss.[14] This difference could be due to the small sample size in our study. Among children with birth asphyxia, 53.3% had abnormal BERA on initial screening while hearing the loss in birth asphyxia has been reported

to be about 43.3%.[14] This difference in our study may be due to the exclusion of the HIE stage I cases from our study. Mishra et al showed that among various neonatal factors, only stages of HIE and duration of neurological symptoms more than 5 days were significantly associated with auditory evoked response abnormalities.[15] But in our study, various neonatal factors related to HIE and BERA abnormalities did not show any statistically significant difference. This may be due to small sample size. Mishra et al[15] concluded that BERA abnormalities in asphyxiated neonates were transient and revert back to normal at 3 months of age. BERA does not appear to be a useful tool for early detection of neurological handicaps in asphyxiated neonates. But in our study, 2 cases with HIE -III developed persistent BERA abnormality with neuro deficit on DDST, even after six months follow up. Our study did not include the HIE stage I.

In our study, we did not find neonatal sepsis ± meningitis as a significant risk factor for persistent BERA abnormality. This observation is similar to the one reported study where they also did not find any significant correlation between sepsis ± meningitis with hearing impairment.[16]

Hearing deficit is a relatively common sequelae of brainstem encephalopathy, possibly due to brainstem lesions in kernicterus. However, with the current management of neonatal hyperbilirubinemia, the incidence of bilirubin encephalopathy is probably decreasing. Nevertheless, some workers have detected subtle damage to the brainstem in neonates with hyperbilirubinemia at relatively lower serum bilirubin levels.[9] In our study, 30.76% had hyperbilirubinemia and a greater number of exchange transfusions were related to significantly abnormal BERA on initial screening. This observation is similar to other reported studies.[16]

In our study, premature babies with co-morbidities in form of hypocalcemia and hypoglycemia, apnea, prolonged use of oxygen had a significant hearing abnormality on initial screening as compared to those without co-morbidities. Gupta et al identified that neonates with multiple predisposing risk factors such as prematurity, low birth weight babies, hyperbilirubinemia, birth asphyxia, neonatal seizures, infections, aminoglycoside administration, and congenital malformation had more BERA abnormality than single risk factor.[17] In their study, only two factors such as hyperbilirubinemia at a level exceeding indication for exchange transfusion and birth weight <1500 gm were found to be significantly correlated with the hearing impairment in the affected neonates.

Conclusion

The goal of hearing screening is to identify those infants with hearing loss early so that prompt intervention can be done to diminish the morbidity associated with hearing loss. Neonates with high-risk factors should have hearing screening by the age of one-month confirmation by 3 months and intervention by 6 months of age.

Compliance with Ethical Standards

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Conflict of Interest: None

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